PATENT SPECIFICATION

(11) 1 225 907

DRAWINGS ATTACHED

1 225 907

(21) Application No. 29916/69 (22) Filed 12 June 1969

(31) Convention Application No. 742 311 (32) Filed 3 July 1968 in

(33) United States of America (US)

(45) Complete Specification published 24 March 1971

(51) International Classification H 05 b 7/18

(52) Index at acceptance

H5H 2A2B 3C 3D
B3R 21X 22J 24 31 32J 37A1D 37A1E
B3V 4B1

(72) Inventors WILLIAM J. DAHLMAN and LEE F. BUDDS

(54) PLASMA TORCH

(71) We, NORTH AMERICAN ROCKWELL CORPORATION, a corporation organized and existing under the laws of the State of Delaware, United States of America, of 2300 East Imperial Highway, El Segundo, California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Conventional plasma torches, well-known in the art, are normally controlled from a location remote from the torch itself. Cables containing the electrical wires and the tubing for the inert gas lead from a control module to the torch, with no means to control the torch from the working end. An obvious disadvantage of this type of torch is that the controls are located away from the operator which sometimes necessitates an additional man to operate the controls. This type of operation is inefficient and time consuming. In addition, if the operator wants to change the arc on his torch to perform a different function he must again readjust the controls at the remote location and therefore cannot change from one mode to a different mode without going back again to the control module.

Conventional art plasma torches operate in the transferred mode only; i.e., the arc is established between the electrode and the grounded workpiece. The non-transferred mode; i.e., arcing between the electrode and the grounded nozzle, is used only initially to start the torch, whereupon the arc immediately transfers to the workpiece during operation. This known type of torch cannot utilize the non-transferred mode during operation, which mode lends itself to other types of torch operations such as cutting, brazing and soldering.

When an inert gas is used to purge the workpiece prior to welding with known torches, the purge gas is brought in through a separate line. The cold purge gas can cause minute fissures or "crater cracking" in the weld and surrounding areas.

Conventional plasma torches are at a further disadvantage in that they must be "scratch-started"; i.e., the starting electrode comes into contact with the grounded part of the torch and is backed away after starting. This causes excessive burning of the tungsten starting electrode.

It is an object of this invention to provide a plasma torch which incorporates all of the controls in the torch handle which are necessary to change the operating variables so that the operator can make minute adjustments as the situations arise at the workpiece site itself.

According to the invention there is provided a plasma torch adapted to be hand held comprising an electrode, a torch head forming an ionizing chamber about the electrode with a nozzle forming a plasma jet exit from the chamber, conduit means for supplying an inert gas to the chamber, the conduit means including a conductive portion electrically connected to the electrode for supplying current thereto, a housing forming a torch handle enclosing the said conductive portion and abutting the torch head, a current control device within the housing for adjusting the current flow to the electrode, and switch means within the housing for use in controlling selective connection of ground to a workpiece or the nozzle for operating the torch alternatively in a transferred mode or a non-transferred mode, each of the current control device and the switch means having an operating portion extending through a wall of the housing so as to be manually operable. The current control device can comprise a combination on-off switch and current control rheostat.

The torch containing the current control device and the switch means within the torch

[Price 25p]

itself obviate the necessity for a second operator at controls which are located remote from the torch operator. The torch operator can change the variables on the torch itself without relying on the judgment of a second operator at a remote control panel. Thus a better welding or cutting operation can be realized because of the instant ability to make minute torch adjustments as conditions change.

The operator can switch from a transferred mode to a non-transferred mode and back to a transferred mode at will, merely by manipulating a button on the torch. The non-transferred mode can be used for a variety of torch operations. For example, the torch can be used for light welding, brazing or soldering by setting the parameters on the torch to suit conditions. Conventional plasma torches operate in the transferred mode only. Once the arc struck to the workpiece is broken, the torch must be started again while the preferred embodiment of the invention automatically reverts to the transferred mode when the arc struck to the workpiece is broken.

Further, the operator, at will, and depending upon the heating requirements of each particular operation, can establish the required settings, utilizing the current control rheostat mounted in the torch housing. In this manner either a decrease or increase in current may be selected as required, or a continuous setting may be maintained for any given length of time while the plasma arc is operating.

The inert gas used to purge the workpiece prior to welding can be heated in the torch itself, thereby obviating the possibility of "crater cracking" or fissures that are caused by the addition of cold inert gas from known torches. The electrode can be located a set distance from the grounded nozzle of the torch head for a non-transferred start, utilizing a high frequency voltage which obviates the necessity of "scratch starts", thereby preventing excessive burning of the tungsten electrode. The electrode is not moved after starting the torch in the non-transferred mode.

Water cooling as opposed to air cooling is preferably utilized. Conventional torches are air cooled, requiring multiple fins for heat dissipation, making the torch relatively large and cumbersome.

The invention will be more fully described, by way of example, in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic of the electrical circuit utilized to operate the plasma torch;

Fig. 2 is a perspective view of the plasma torch illustrating the various controls;

Fig. 3 is a side partial, cutaway, elevational view of the torch showing the locations of all the controls,

Fig. 4 is a section taken through the torch head illustrating the location of the electrode in relation to the gas passages, etc.

Fig. 5 is a view taken along lines 5—5 of Fig. 3 illustrating the location of the exiting purge orifices.

Referring to Fig. 1, a module 10 is flexibly connected to a torch 24 by a length of multiple tube conduit 22. The module 10 contains a power source 12, a high frequency starting circuit 18, a transfer/non-transfer selecting circuit 20, as well as the water supply 14 and an inert gas supply 16, all of which are controlled at the torch 24. The torch 24 consists of a housing 26 having affixed thereto a water jacketed torch head 28, a variable rheostat 32 and a transfer/non-transfer switch 36.

In operation, the module 10 is switched on at the workpiece site by the rheostat 32 fixed to the torch 24. The rheostat is turned to the desired setting which triggers the following sequence of events at the module 10.

The circulating water and inert gas supplies 14 and 16 start first, under the control of solenoid valves and a conventional timing system (not shown) which allows water and gas to flow a set time prior to initiation of the high frequency starting circuit 18. The high frequency circuit creates an arc between the electrode 54 and the torch head 28, thereby ionizing the surrounding inert gas. Immediately after starting, the high frequency circuit automatically switches off and the torch 24 is ready for use. A high frequency circuit as suggested in Marks' Mechanical Engineers' Handbook, edited by T. Baumeister, McGray Hill, 6th edition 1958, page 13—34, second paragraph, may be employed. To transfer the arc from the torch 24 to the workpiece 29, the transfer/non-transfer switch 36 is depressed, which removes the ground from the torch head 28 and transfers it to the workpiece 29. When the torch is moved away from the workpiece, the arc automatically reverts back to a non-transfer mode. A simple circuit utilizing a latching relay and a voltage sensor is employed in the module 10. When the arc voltage increases to a set value, the latching relay is re-engaged, thereby automatically transferring the ground to the torch (non-transferred mode). To transfer the arc back to the workipece 29, the operator again depresses the switch 36.

Fig. 2 is a perspective view of the torch 24 which best illustrates the location of the operating portion of the rheostat 32, this portion being of disc-like shape, and the transfer switch button 36 which are attached by screws to mounts integral with one half shell of the housing 26. The torch is fully operational by one hand. The operator can set the rheostat 32 to the optimum setting, by finger tip dependent upon the job require-

ments. The housing 26 comprises two half shells 27, preferably of reinforced plastics which retain the torch head 28 and are clamped together by screws 30 mated in female bosses 31 located in one half shell 27 (Fig. 3). A rubber cap 34 protects a live retaining cap 48 shown in Fig. 3.

With reference to Figs. 3 and 4, the torch head 28 is brazed to a metal inert gas inlet 76 and water inlet and outlet conduits 84 and 86 which serve as structural support members for the torch 24. The metal tubing is routed around the rheostat 32 and the switch 36, terminating at connectors 70, 78 and 79 located towards the rear handle part of the torch 24. The metal lines are electrically isolated from wires and components in the torch body by protective sleeves 88. The conductive metal conduits 76, 84 and 86 serve an additional function. The live wire 72 from the power source 12 is routed inside a rubber inert gas conduit 38 secured to the end of the metal conduit 76 and is soldered to the connector 70, whereby the conduit 76 carries the current to the electrode housing 44. The inert gas passing over the wire 72 serves to cool the wire. The ground wire 80 from the transfer/non-transfer circuit 20, is routed through a rubber water conduit 40 connected to metal conduit 84 and soldered to the connector 78, which grounds the metal water conduit 84 terminating at a water jacket 46. The ground wire is thus cooled by the cooling water.

Fig. 4 is a detail of the torch head 28. A retaining cap 48, electrode housing 44, a sleeve 52 and the tungsten electrode 54 are electrically isolated from the water jacket housing 46 by a PTFE insulator 60. An inner sleeve 56 is screwed on to the insulator 60 and is welded to the outer housing 46, the space therebetween defining a circulating water chamber 50. A plasma arc jet nozzle 62 serves as a ground electrode for the electrode 54 in the non-transfer mode and is screwed into the inner sleeve 56. The nozzle 62 is interchangeable with alternative nozzles having central orifices 65 of various sizes.

Fig. 5 is a bottom view of Fig. 4 which more clearly shows a gas diffuser 66, a retaining ring 68, the nozzle 62 and the relationship of the water inlet and outlet lines 84 and 86.

The torch 24 operates as follows: prior to ignition, water is circulated down the conduits 40 and 84 from the water source 14, around the chamber 50 and back to the water source 14 through the water return conduits 86 and 42. At the same time, purge gas from the gas source 16 is routed through the conduits 38 and 76 into an upper inert gas chamber 51, through ports 53 into a chamber 58 and out through ports 64 and 65 in the nozzle 62. Part of the inert gas flow is diffused through the gas diffuser 66. The gas diffuser is retained by the spring retaining ring 68 which is biased against an annular groove 69 in the housing 46. After a timed interval, the high frequency circuit 18 initiates an arc between the nozzle and the electrode, starting the torch, and then turns off. The adjustable tungsten electrode 54 is set to about 0.070" between the tip of the electrode and nozzle 62 which is close enough for the high frequency system to create the arc, thereby obviating the necessity of a "scratch start". Some of the preheated inert gas passes out of the chamber 58 through the ports 64 and is diffused through the gas diffuser 66 onto the workpiece.

The power source 12 normally has a capacity of 50 amps which allows the torch to be used in a variety of different ways. The torch flames have a range from 200°F up to 24,000°F merely by turning the rheostat 32 to the desired setting. Thus, the operator has the capability ranging from welding solder to cutting high strength steels. Therefore, the miniature torch is highly versatile.

WHAT WE CLAIM IS:—

1. A plasma torch adapted to be hand held comprising an electrode, a torch head forming an ionizing chamber about the electrode with a nozzle forming a plasma jet exit from the chamber, conduit means for supplying an inert gas to the chamber, the conduit means including a conductive portion electrically connected to the electrode for supplying current thereto, a housing forming a torch handle enclosing the said conductive portion and abutting the torch head, a current control device within the housing for adjusting the current flow to the electrode, and switch means within the housing for use in controlling selective connection of ground to a workpiece or the nozzle for operating the torch alternatively in a transferred mode or a non-transferred mode, each of the current control device and the switch means having an operating portion extending through a wall of the housing so as to be manually operable.

2. A plasma torch according to claim 1, wherein the current control device is mounted adjacent the said conductive portion.

3. A plasma torch according to claim 1 or 2 wherein the operating portion of the current control device is of disc-like shape and extends outwardly through an aperture in the housing.

4. A plasma torch according to claim 1, 2 or 3, wherein the housing comprises two half shells, one of the half shells including means for mounting the current control device and the switch means.

5. A plasma torch according to any of claims 1 to 4, wherein the current control device is a rheostat.

6. A plasma torch according to any of claims 1 to 5, wherein the conduit means comprises at least one flexible tube extending to the conductive portion which is rigid, a power lead being routed inside the flexible tube to the conductive portion of the conduit means.

7. A plasma torch according to any of claims 1 to 6, wherein the said conductive portion of the conduit means is rigidly attached to the torch head and serves as a structural support member between the head and housing.

8. A plasma torch according to any of claims 1 to 7, including a cooling chamber within the torch head and inlet and outlet conduit means within the housing communicating with the chamber.

9. A plasma torch according to any of claims 1 to 8, in combination with a module remote from the torch but connected thereto by flexible electrical leads and conduit(s), the module including a power source responsive to the current control device to control the current to the electrode, and a selecting circuit responsive to the switch means to apply ground selectively to the nozzle of the torch head by way of a first lead or to a second lead which may be connected to a workpiece.

10. A plasma torch and module according to claim 9, insofar as dependent on claim 8, wherein the said first lead is connected to the nozzle of the torch head by way of a conductive portion of the said conduit means communicating with the cooling chamber.

11. A plasma torch and module according to claim 9 or 10, wherein the selecting circuit is arranged to respond to operation of the switch means to apply ground to the second lead and is automatically responsive to increase in the arc voltage to a predetermined value to apply ground to the first lead.

12. A plasma torch according to any of claims 1 to 8, wherein it is arranged that, in operation, the inert gas is heated within the torch and a portion of the gas is ionized by the electrode, apertures about the periphery of the ionizing chamber and annular exit means surrounding the plasma jet exit being arranged to distribute a portion of unionized heated inert gas on to a workpiece.

13. A plasma torch substantially as described with reference to and as illustrated in the accompanying drawings.

REDDIE & GROSE,
Agents for the Applicants,
6, Bream's Buildings,
London, E.C.4.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1971.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

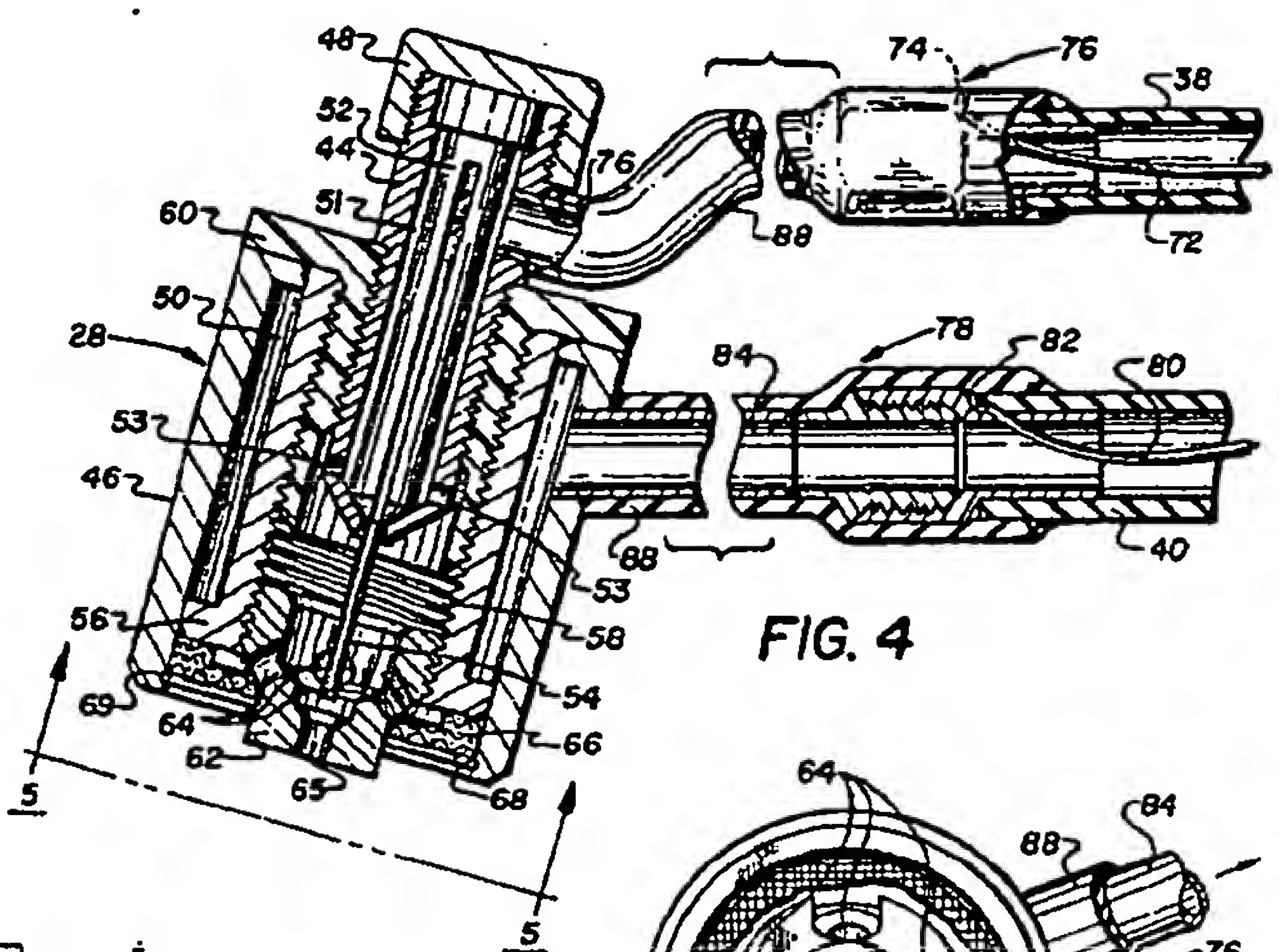

FIG. 4

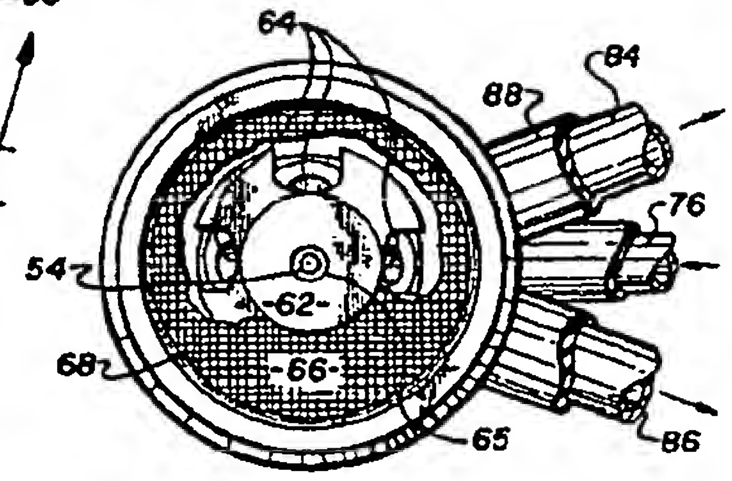

FIG. 5

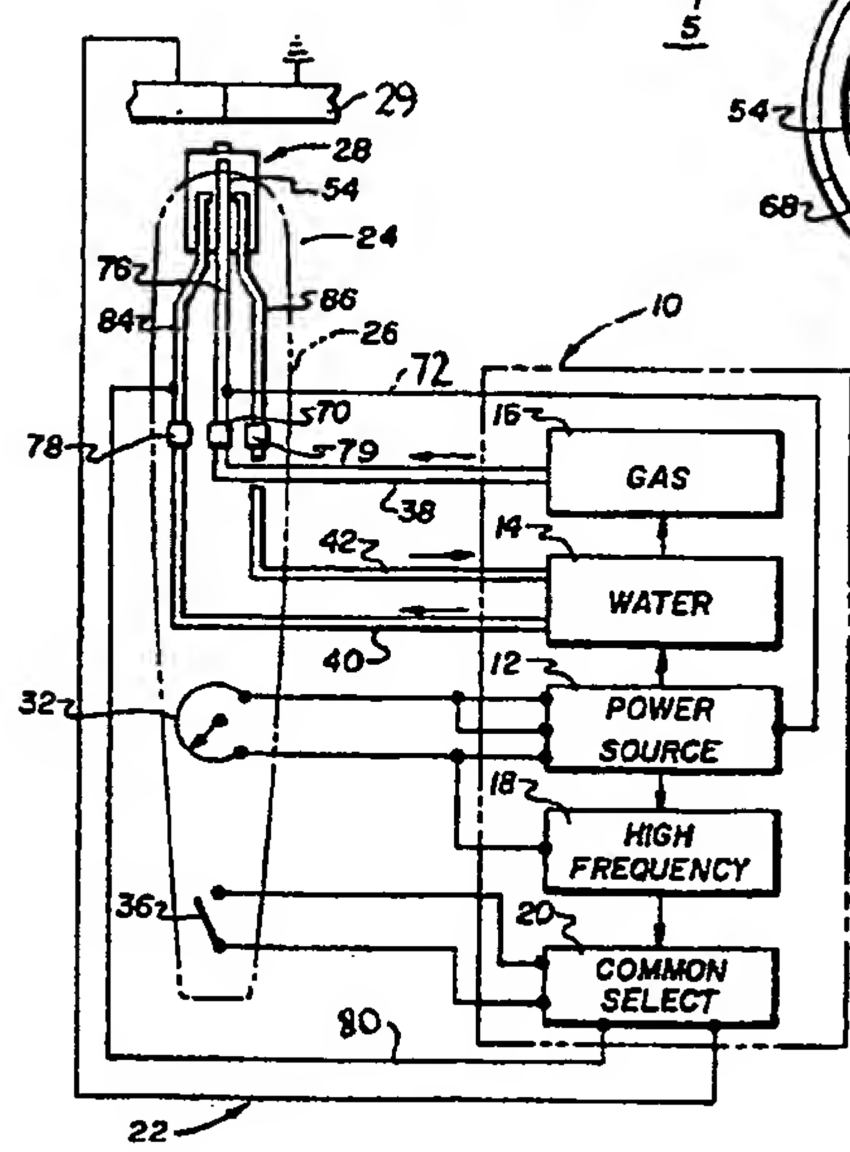

FIG. 1

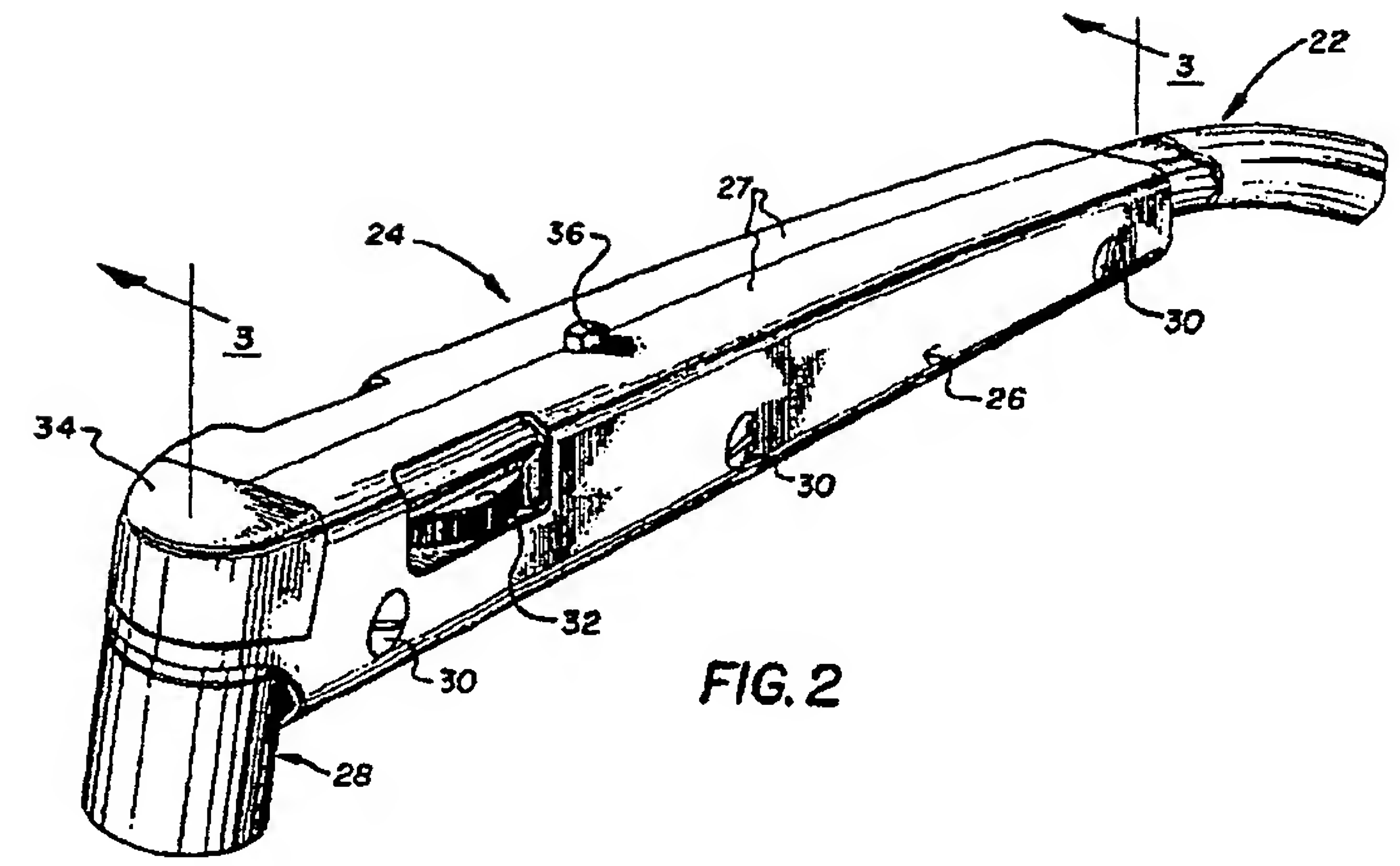
3
22
27
24
36
30
26
3
34
30
32
30
28

FIG. 2

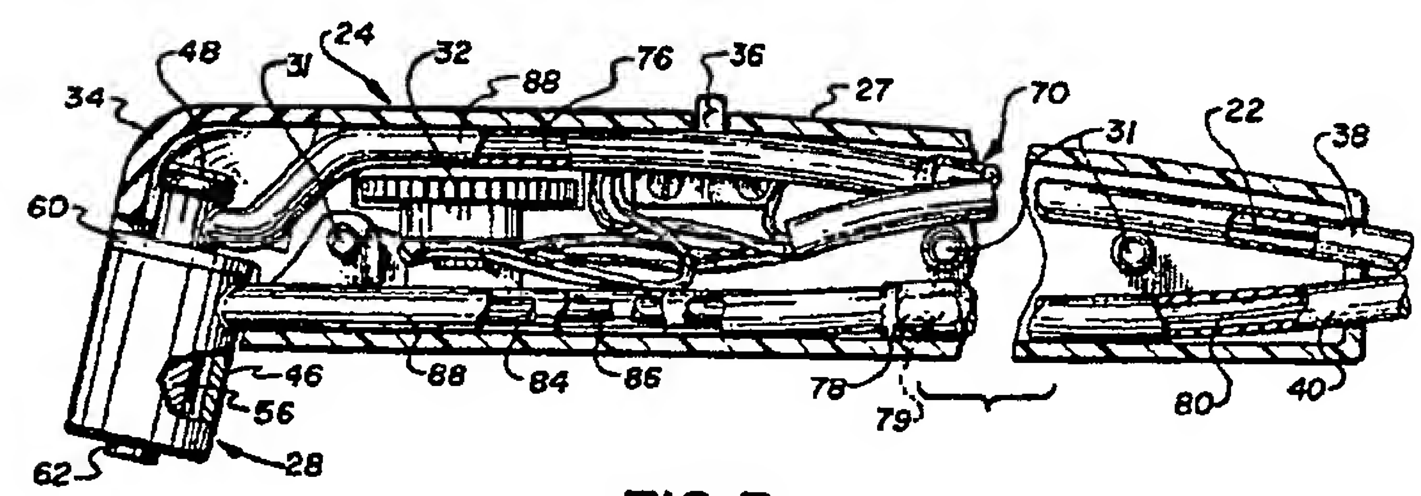
24
48
31
32
88
76
36
27
70
34
31
22
38
60
46
88
84
86
78
79
80
40
56
62
28

FIG. 3